


## PCT

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P-IEE-099WO	<b>FOR FURTHER ACTION</b> See Form PCT/PEAA16	
International application No. PCT/EP2004/053509	International filing date (day/month/year) 15.12.2004	Priority date (day/month/year) 17.12.2003
International Patent Classification (IPC) or national classification and IPC B60R21/01		
Applicant IEE INTERNATIONAL ELECTRONICS & ENGINEERING S.A.		
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 5 sheets, as follows:</p> <p><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>		
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input checked="" type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>		
Date of submission of the demand  28.06.2005	Date of completion of this report  18.11.2005	
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Plenk, R  Telephone No. +49 89 2399-7733	



INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITYInternational application No.  
PCT/EP2004/053509**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

**Description, Pages**

1, 4, 6-11 as originally filed

2, 3, 5 filed with telefax on 14.09.2005

**Claims, Numbers**

1-13 filed with telefax on 14.09.2005

**Drawings, Sheets**

1/2, 2/2 as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs.
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/EP2004/053509

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	1-13
	No: Claims	
Inventive step (IS)	Yes: Claims	1-13
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-13
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

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**Box No. VII Certain defects in the international application**

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The following defects in the form or contents of the international application have been noted:

**see separate sheet**

**Re Item V**

**V.1 Prior Art**

Reference is made to the following documents:

D1: DE 196 25 730 A

D2: BILLEN K: "Occupant Classification System for Smart Restraint Systems" SAE PAPER 1999-01-0761, XX, XX, January 1999 (1999-01), pages 33-38, XP002184965

D3: US-B-6 345 839

**V.2 Independent Claim 1**

1. The subject-matter of claims 1 and 12 meets the requirements of the PCT regarding novelty and inventive step (Article 33(2, 3) PCT).

D1 discloses a

device for the detection of seat occupancy, comprising:

a sensing layer (F1, F2 and intermediate semiconductor layer, Figure 2) associated to a seating surface of a seat (Figure 4), said sensing layer having at least one electrical property varying in response to a pressure and/or deformation applied to said sensing layer (resistance),

a plurality of electrodes (Z1 - Z4, S1 - S3), said electrodes being associated to said sensing layer at a periphery of a sensing area, and

a control unit ( $\mu$ -processor) connected to said electrodes, said control unit comprising means for evaluating a pressure profile acting on said sensing layer by determining said at least one electrical property between pairs of electrodes selected from said plurality of electrodes, see also column 2, line 68 to column 4, line 27.

Similar devices are known also from D2, Figure 6, and D3, column 6, line 60 to column 7, line 30, Figures 2 and 3.

2. A difference between the subject-matter of the independent claims 1 and 12 and the prior art is that the application provides the electrodes **only** at the periphery of the sensing area. This is not the case in the available prior art. In D1, the electrodes extend over the whole sensing area, see Figure 2. The same is the case in D2 and D3.

There is no indication in the available prior art to provide this electrode arrangement. The subject-matter of the independent claims 1 and 12 therefore meets the requirements of the PCT regarding novelty and inventive step (Article 33(2, 3) PCT).

### **V.3 Dependent Claims**

The dependent claims relate to further embodiments. They meet the requirements of the PCT regarding novelty and inventive step due to their dependency.

### **V.4 Industrial Applicability**

The subject-matter of claims 1 to 13 seems to fulfil the requirement of Article 33(4) PCT since it can be used at least in the vehicle industry.

### **Re Item VII**

Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT). Claim 12, however, is correctly cast in the one-part form since using the two-part form would render the reading and understanding complicated. This is, however, not the case with claim 1. The description does not state what feature from claim 1 are disclosed in D1 (Rule 5.1(a) PCT).

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each cell and accordingly can be related to the weight acting on the seat. Furthermore the distribution of the pressure values over the surface of the seat can be related to the size or the form of a person or an object occupying the seat. Different methods in which a classification of a seat occupancy is based on several parameters extracted from the recorded pressure profile are e.g. disclosed in International applications WO-A-99/38731, WO-A-03/016100 and WO-A-03/023335.

A typical seat occupancy sensor, which may be used for detecting seat occupancy, is disclosed in document DE-A-42 37 072. This occupancy sensor, which is suitable for recording a pressure profile acting on a seating surface of a seat, comprises a plurality of individual pressure sensors, which are arranged in an array and associated at several locations to the seating surface of the vehicle seat. The individual pressure sensors are formed on two carrier foils and interconnected by strips made of these carrier foils. These strips of carrier foils also carry the conducting lines which are necessary to electrically interconnect the individual pressure sensors in a suitable configuration.

<.>  
This configuration of the typical seat occupancy sensors leads to rather complicated designs of the sensor mat and the interconnecting strips as due to production requirements, a crossing of the electrical conducting lines should be prevented. It is clear, that the problem exponentially increases with a number of individual sensor cells of the sensing mat. Thus the number of individual pressure cells in a classical seat occupancy sensor is limited by the design constraints of the sensing mat.

It is clear, that the limitation of the number of individual sensors constitutes a limitation to the spatial resolution of the sensing which may reduce the field of application of these sensors. In fact, in order to be able to classify a passenger based on his pressure profile on the seat, it is preferably to record the pressure profiles with a high geometrical resolution. Only such a high geometrical resolution of the pressure profile ensures a high reliability of the pressure profile pattern analysis in order to isolate the correct characteristics of the passenger class.

<Another such typical seat occupancy sensor is known from document DE 196 25 730 A1.>

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For the occupant classification, it would thus be preferable to use seat occupancy detectors, having a higher spatial resolution than the classical seat occupancy sensing mat.

**Object of the invention**

5 The object of the present invention is to provide an improved seat occupancy detector.

**General description of the invention**

In order to overcome the abovementioned problem, the present invention proposes a device for the detection of seat occupancy, comprising a sensing layer associated to a seating surface of a seat, which has at least one electrical property varying locally in response to a pressure and/or deformation applied to  
10 said sensing layer. Further to said sensing layer, the device comprises a plurality of electrodes associated to said sensing layer<sup>only</sup> at a periphery of a sensing area, and a control unit connected to said electrodes, said control unit comprising means for evaluating a pressure profile acting on said sensing layer by determining said at least one electrical property between pairs of electrodes  
15 selected from said plurality of electrodes.

In contrast to the known seat occupancy sensing mat, the device of the present invention is based on the determination of a locally changed electrical property of a sensing layer covering the sensing area of the device. This local change of electrical property is sensed between pairs of electrodes, which are connected  
20 to the sensing layer at a periphery of the sensing area. By measuring the electrical property between a plurality of pairs of electrodes, a two-dimensional profile of the electrical property can be recorded, which is correlated to the 2D pressure profile of a seat occupant in the seat. This pressure profile may subsequently be used in a classification algorithm in order to classify the  
25 occupancy in one on a plurality of classes having a specific airbag deployment mode associated therewith.

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to a seating surface of a seat, said sensing layer having at least one electrical property varying in response to a pressure and/or deformation applied to said sensing layer, said method comprising the steps of:

- 5 a) determining said at least one electrical property of said sensing layer between pairs of different locations situated <sup>only</sup> at a periphery of a sensing area, and
- b) evaluating a pressure profile acting on said sensing layer based on the determined electrical property values.

10 The evaluation of the pressure profile is preferably achieved based on a 2-dimensional profile of the electrical property of the sensing layer. This 2-dimensional electrical property profile is advantageously obtained by a tomography imaging method so that said control unit preferably comprises means for evaluating said pressure profile using a tomography imaging method.

15 The method comprises e.g. the application of an electrical voltage to a first electrode and subsequently the measurement of an electrical voltage or current at one or more electrodes located generally opposite the first electrode. This operation is then successively repeated for a plurality of electrodes in order to obtain a measurement values for a plurality of regions of the sensing layer. These measurement values are then processed in order to plot an electrical

20 property distribution within the sensing layer. This electrical property distribution is then correlated to the pressure profile acting on the sensing layer.

The electrical property under investigation should preferably vary uniformly with applied pressure and the relationship between the electrical property and the pressure is preferably described by a simple formula. In a preferred embodi-

25 ment, the sensing layer is designed so that the electrical property is proportional to the pressure acting locally on the sensing layer.

The electrical property may e.g. comprise the electrical impedance of said sensing layer. If the control unit operates with DC voltages, the at least one electrical property comprises the electrical resistance or conductance of said

30 sensing layer. Electrical Impedance Tomography EIT (where Impedance can be Resistance or Capacitance) or Electrical Resistance Tomography ERT are



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## Claims

1. Device for the detection of seat occupancy, comprising  
a sensing layer associated to a seating surface of a seat, said sensing layer  
having at least one electrical property varying in response to a pressure  
and/or deformation applied to said sensing layer,  
5 a plurality of electrodes, said electrodes being associated to said sensing  
layer only at a periphery of a sensing area, and  
a control unit connected to said electrodes, said control unit comprising  
means for evaluating a pressure profile acting on said sensing layer by de-  
termining said at least one electrical property between pairs of electrodes  
10 selected from said plurality of electrodes.
2. Device according to claim 1, wherein said control unit comprises means for  
evaluating said pressure profile using a tomography imaging method.
3. Device according to any one of claims 1 to 2, wherein said at least one  
electrical property comprises the electrical impedance of said sensing layer.
- 15 4. Device according to any one of claims 1 to 3, wherein said at least one  
electrical property comprises the electrical resistance or conductance of  
said sensing layer.
5. Device according to any one of claims 1 to 4, wherein said sensing layer  
comprises a rubber material having an internal electrical impedance which  
20 varies in dependence with a deformation of the material.
6. Device according to any one of claims 1 to 5, wherein said sensing layer  
comprises a foam material having an internal electrical impedance which  
varies in dependence with a deformation of the material.
7. Device according to any one of claims 1 to 6, wherein said sensing layer  
25 comprises  
a first carrier foil having at least one surface covered with a resistance ma-  
terial  
a second carrier foil having at least one surface comprising a plurality of  
areas covered with a conductive material

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- said first and second carrier foil being arranged at a certain distance from each other by means of a spacer material such that said areas covered with conductive material of said second carrier foil face said coating of resistance material of said first carrier foil.
- 5 8. Device according to claim 7, wherein said resistance material is printed onto said at least one surface of said first carrier foil.
9. Device according to any one of claims 7 to 8, wherein said conductive material is printed in said areas onto said at least one surface of said second carrier foil.
- 10 10. Device according to any one of claims 7 to 9, wherein said spacer material comprises an adhesive, which is arranged in a plurality of localized areas between said first and second carrier foil.
11. Device according to any one of claims 7 to 10, wherein said spacer material comprises a printable adhesive, which is printed in a plurality of localized areas onto one of said carrier foils.
- 15 12. Method for the detection of seat occupancy, said method employing a sensing layer associated to a seating surface of a seat, said sensing layer having at least one electrical property varying in response to a pressure and/or deformation applied to said sensing layer, said method comprising the steps of:
- 20 a) determining said at least one electrical property of said sensing layer between pairs of different locations situated only at a periphery of a sensing area, and
- b) evaluating a pressure profile acting on said sensing layer based on the determined electrical property values.
- 25 13. Method according to claim 12, wherein said step of evaluating said pressure profile uses a tomography imaging method.